Smart Crop Suitability System

Project ID: 19-015

Requirement Design Document

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DECLARATION

I hereby declare that the project work entitled “Smart Crop Suitability System” submitted to the Sri Lanka Institute of Information Technology, is a record of original work done by our group under the guidance of Dr. Anuradha Jayakody (Supervisor), and this project work is submitted in the fulfilment of the award of the Bachelor of Science (Honors) in Information Technology Specialized in Software Engineering. The results embodied in this report have not been submitted to any other University or Institute for the award of any degree or diploma. The diagrams, research results and all other documented components were developed by me and I have cited clearly any references I have made.

Author:

H.P.H.S.Hemapriya　　Signature :...

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1. INTRODUCTION

1.1 Purpose

The purpose of this document is to provide a detailed description of recommending fertilizer for the selected crop to have a successful harvest component of "Smart Crop Suitability System" application. This DD document will explain the purpose and features, the interfaces, what the implementation of this part will do and the constraint under which it must operate. This is intended for both the stakeholders and developers of the product, and defines how our client, team, and audience see the product and its functionality.

1.2 Scope

This is one of the main components of the research and the main goal of this component is to recommend necessary amount of fertilizer a farmer should use to have a successful harvest from the application suggested crops. Addition to that recommending suitability of a crop searched by the farmer will also be achieved through this. This component consists of four sub components as,

- Retrieve average sensor data (pH, EC, Humidity, Temperature)
- Analyse soil nutrient deficiency
- Recommend fertilizers
- Suggest suitability of crops searched by farmer with fertilizer plan

Retrieve average sensor data component which uses stored sensor readings in cloud server and generate average pH, temperature, Humidity and EC nutrient levels existing in the particular land in order to suggest a suitable fertilizer.

When the farmer selects a crop from application suggested crop list, analyze soil nutrient deficiency component compare and analyze existing nutrient percentages of soil with in-built crop dataset, with relevant to selected crop and generate nutrient deficiency in soil.

Recommend fertilizers for selected crops component compare soil nutrient deficiency with in-built fertilizer dataset in database using data mining technique in machine learning algorithms, suggest the amount of fertilizer a farmer should use for application suggested crops in order to have a successful cultivation and avoid soil degradation. [1]

As well, developing the android application to generate and display the average sensor reading details, recommend fertilizers and handling the database will also be covered from this component.

1.3 Definitions, Acronyms, and Abbreviations

EC	Soil Electrical Conductivity
Machine Learning	Field of computer science that uses a statistical technique to give computer systems the “learn” with data, without being explicitly programmed.
Data Mining	process to discover various types of pattern that are inherited in the data and extracting knowledge from a large amount of data
DD	Design Document

Table 1 - Definitions, Acronyms, and Abbreviations

1.4 Overview

The first chapter focused on the introduction to this application. This application is mainly targeted an easy way to realize the most suitable crop that can be grown in a particular land with a fertilizer plan in order to have a successful cultivation and avoid soil degradation due to excess fertilizer usage.

In the second chapter of the document provides overall description of the functionality and interaction with the other component. This section also discusses the interfaces, constraints and operations to provide better understanding of the product. Further it explains characteristics of users, constraints of the system, comparison with an existing product, assumptions, and dependencies, and apportioning of requirements.

From the third section of the document, user specifications, risks of the hardware components, architectural design details are described and maintainability, security and the references are provided at the bottom section of the document.

Our main target audience would be farmers and new cultivators and both second and third chapters are explaining the same product in two different languages since this document uses a different audience.

2. OVERALL DESCRIPTION

Recommending fertilizer for application suggested crops is a major part of this application. In order to suggest the fertilizer, mobile application retrieve stored sensor data (pH, EC, Humidity, Temperature) in cloud server and generate the average nutrient levels existing in the particular land.

When farmer select a application suggested crop, using in built data set with relevant to crops, application will identify the approximate amount of nutrient levels that should be in land in order to have the successful harvest from the relevant cultivation. Then application generate the deficiency amount of nutrient levels in existing soil to have better harvest by comparing identified data with existing nutrient levels. By using a data mining technique in machine learning algorithms,[1] application will compare deficiency nutrition levels with in - build data set with relevant to fertilizer, and will recommend necessary amount of fertilizers a farmer should use in order to have the best harvest.

If by any chance farmer wanted to grow different crop other than crops included in suggested list, he can search for that crop details. If the requested crop can be grown in the land only by adjusting the existing nutrient levels in soil, application suggest the amount of fertilizer that should be used in order to plant that crop. So the farmer can make the land suitable for that crop to have a better harvest.

2.1 Product perspective

During the literature review we have discovered various systems that predict the crop growth by using different tools and techniques. After the analysis of the systems discovered, each of them contained few defects and minor weaknesses in the technologies that were used.

According to the researchers Joon-Goo Lee and Haedong Lee, they have used image processing techniques for develop same kind of an application. [2]. Also Tasnee Attanandana, Prateep Verapattananirund, and Russell Yost, researchers have implemented a system for Fertilizer recommendation using soil test kits. There they have used a soil series identification tool which is based on a decision-tree concept whereby five factors have been found to be sufficient to identify 38 of the maize producing soils. [3]

Most of those identified products use either expensive sensors or chemicals for the soil tests. But in this proposed system will develop a tool with attaching sensors which will test the main factors like pH, electrical conductivity (EC) of the soil, temperature and humidity of the air. Using retrieved average sensor details, mobile application recommend fertilizers for selected crops by analyzing existing soil nutrient levels with in-built fertilizer dataset.

2.1.1 <u>System interfaces</u>

Smart Crop Suitability System is a cross platform mobile application which is compatible with multiple mobile operating systems. Visual studio will be used as the development environment for this application. phpMyAdmin will use for database management in MySQL.

2.1.2 User interfaces

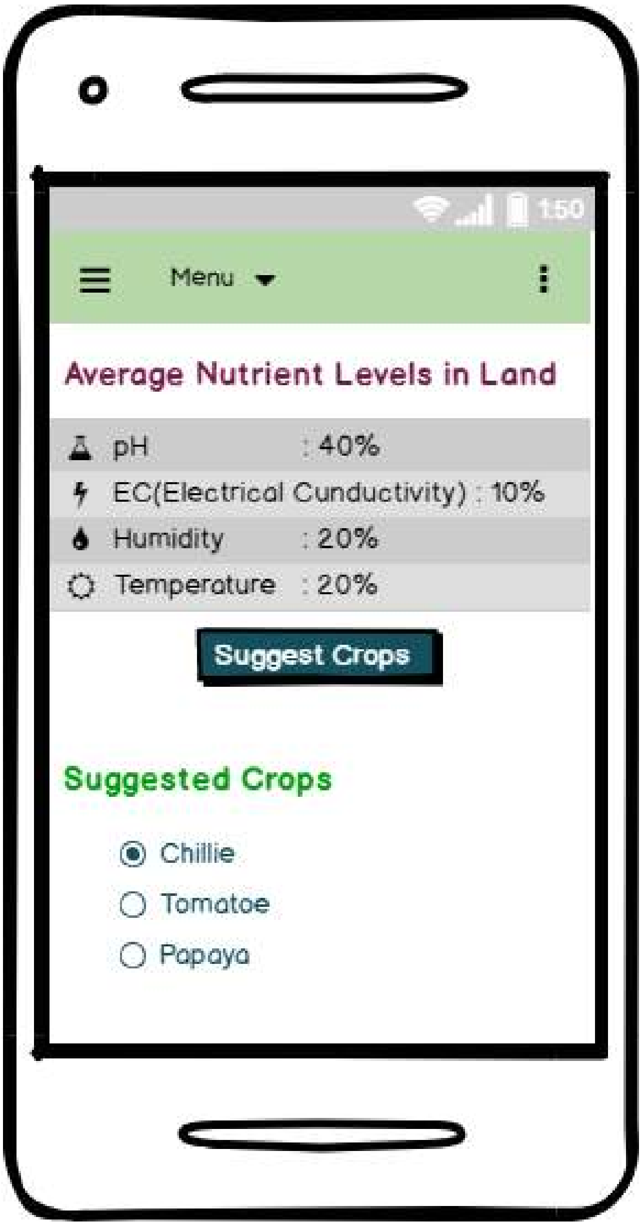

Figure 1 – Navigate to view recommended fertilizers for the selected crop

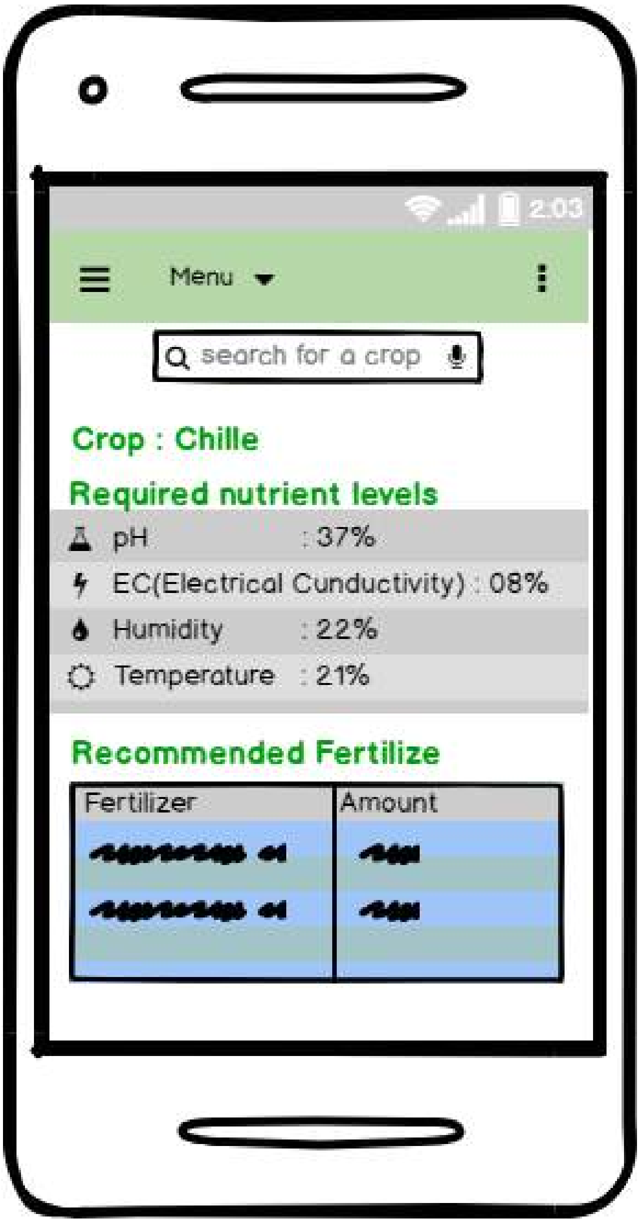

Figure 2 – View required nutrient levels for the selected crop and recommended fertilizer plan

2.1.3 <u>Hardware Interfaces</u>

- EC sensor
- Temperature sensor
- pH sensor
- Humidity sensor
- Raspberry Pie 3 B+
- Smart phone

2.1.4 Software Interfaces

Visual Studio 2015	Developing cross platform mobile application
phpMyAdmin	MySQL database management

Table 2 – Software Interfaces

2.1.5 Communication Interfaces

We use raspberry pi board as our principle sensor center point to get and upload the sensor readings to cloud server. In order to store sensor reading in cloud server Raspberry Pie board and the cloud server will be connected through an API using in built Wi-Fi module in raspberry pi board. Smartphone should be connected to the internet using mobile data or WIFI to retrieve data from cloud.

2.1.6 Memory Constraints

The Mobile application is required,

- Android version should be 5.0 or higher
- 1 GB RAM
- 100 MB Memory space

2.1.7 Operations

Final outcome of this proposed solution is a product and a cross platform mobile application, the mobile application will be interacted with the process for achieving particular goals. Therefore, to use this proposed product, the user should install the "smart crop" mobile application.

1. The user should sign in and if he doesn't have an account, then he should create an account.
2. When the mobile application is going to be used by the user, first he should enter the soil type and area of the particular land where he going to start the cultivation.
3. User should get sensor readings from with the help of sensor embedded tool, until the application suggested required reading count is fulfilled.
4. When taking readings from land user should use zig-zag soil testing method in order to take soil samples from the different places in the land.
5. To take the most accurate readings from sensor embedded tool, user must take reading while the soil is wet.

□

6. For the internet facility, mobile data or wifi should be enabled.

2.1.8 Site adaptation requirements

English will be used for the notifications and the application interfaces. For the communication and other features, mobile mobile data or wifi should be enabled. As well, for the efficiency of the proposed product a database is going to be managed and both fertilizer, crop datasets are going to be stored in database. Sensor readings taken from sensor embedded tool will be uploaded to cloud server and those data will be retrieved by the mobile application through an API for the comparison purpose. MYSQL will be used as the database to compare and achieve the crop and fertilizer suggestions using this mobile application.

2.2 Product functions

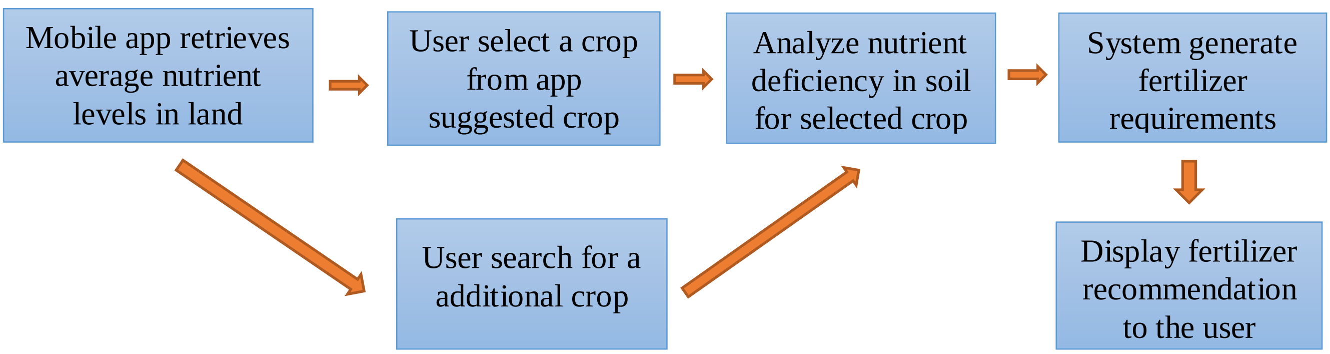

Figure 3 – High level diagram of product function

- Mobile application retrieves average nutrient levels in land
  Mobile application retrieve stored sensor readings from cloud server through an API and generate average nutrient levels in particular land.
- User select a crop from app suggested crop
  When the mobile application suggests suitable crops, user select a crop according to his favour
- User search for an additional crop
  User can search another crop that is not included in suggested crop list

- Analyze nutrient deficiency in soil for selected crop
  System analyses nutrient deficiency in soil for successful harvest from selected crop

- System generate fertilizer requirements
  System compare nutrient deficiency with in-built fertilizer dataset and suggest fertilizer requirements for the crop

- Display fertilizer recommendation to the user
  Mobile application display fertilizer recommendation for app suggested crops and if farmer searched additional crop can be grown in land, App will also recommend fertilizer plan for it.

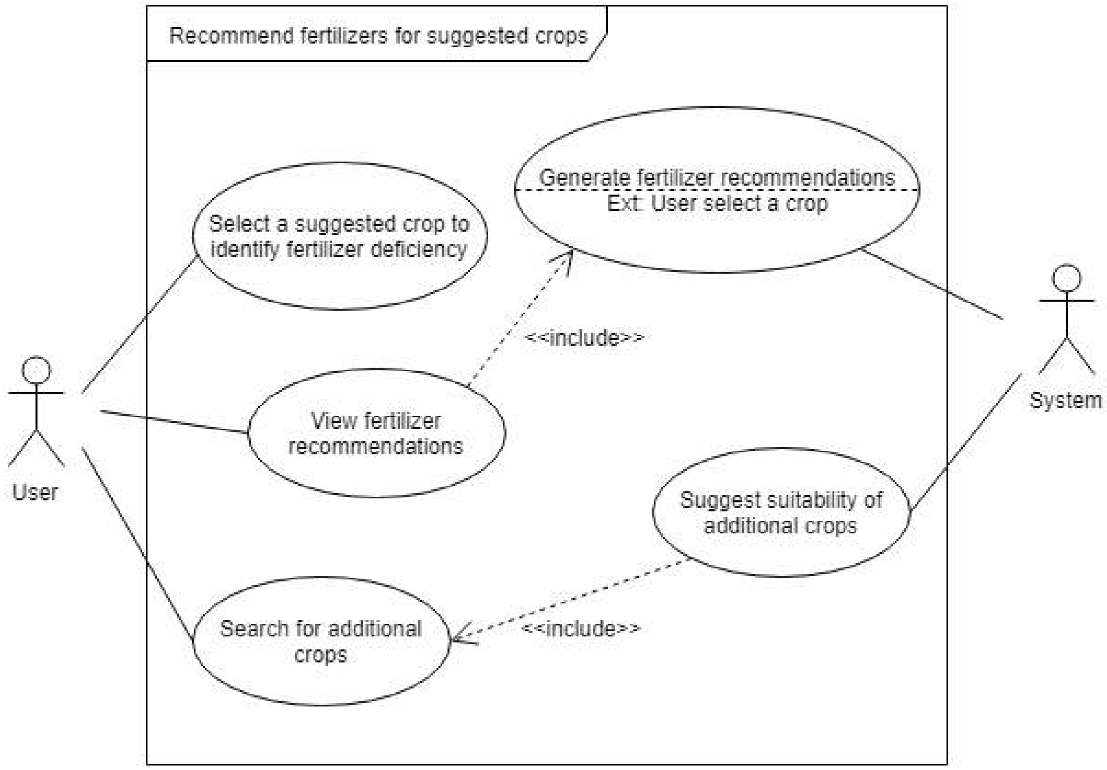

Figure 4 – Use Case Diagram

Use Case Scenario

Use Case 01	Generate Fertilizer recommendations
Primary Actor	System
Pre Condition	System should generate existing average soil nutrient levels and most suitable crop
Main success scenario	User click on “Recommend fertilizers”

Extensions	System should notify user the minimum amount of fertilizer that should be use

Table 3 – Use Case 01

Use Case 02	Suggest suitability of additional crop
Primary Actor	System
Pre Condition	System should generate existing average soil nutrient levels
Main success scenario	User should search the name of the crop on search bar
Extensions	If the requesting crop is suitable, System should notify user about how to arrange the for particular crop

Table 4 – Use Case 02

2.3 User Characteristics

This system is mainly focused on people who has an interest in cultivation. Because the system provides the ability to predict the most suitable crop for the particular ground, even the people who does not have much knowledge on cultivation can use this app without easily. Furthermore, user can obtain a maximum harvest from app suggested crop by applying fertilizers recommend by the app.

2.4 Constraints

- A smartphone is required with enough battery life and storage.
- Raspberry pie board is required to do the data processing using machine learning algorithms
- The performance should be user friendly along with the other software facilities.

2.5 Assumptions and Dependencies

- The smartphone is switched on throughout the process of generating results with the enough power of battery.
- Internet connectivity will be available in the smartphone through the process.
- User will apply fertilizers recommended by the mobile application accurately.

3 SPECIFIC REQUIREMENTS

3.1. External interface requirements

3.1.1. User interfaces

- Select application suggested crop to view fertilizer recommendations.

  User have to select a crop from application suggested crop list in order to request fertilizer recommendations from mobile application, to have successful harvest.

- View fertilizer recommendations

  Mobile application compare required minimum nutrient levels for selected crop with existing land nutrient levels and identify nutrient deficiency. Then suggest amount of fertilizers to have successful cultivation and better profit.

3.1.2. Hardware interfaces

- pH sensor - to identify pH level of the soil
- Temperature sensor - to identify the temperature of the soil
- Humidity sensor - to identify the water level of soil
- Electricity conductivity sensor - to measure ability to conduct electricity
- WIFI module - for communication purpose between the mobile, smart crop suitability tool
- Smart phone - for the mobile application, suggest crops, show locations and user will be notified through the mobile. (Android version 6.0 or higher)
- Raspberry Pie 3 model b+ –as the sensor hub

3.1.3. Software interfaces

Name	Version	Purpose
Visual Studio 2015	2015 or higher	Developing cross platform mobile application
phpMyAdmin	Php version 5.5.12 or higher	MySQL database management

3.1.4. Communication interfaces

Mainly in this component the communication process will be happened through the WIFI connectivity. Therefore, raspberry pi and phone is connected always to retrieve data. As well for the communication between the application and database, and for crowdsourcing, internet facility should be enabled. Moreover, the smart crop suitable system will get the current location using GPS module.

3.2 Architectural Design

3.2.1. High Level Architectural Design

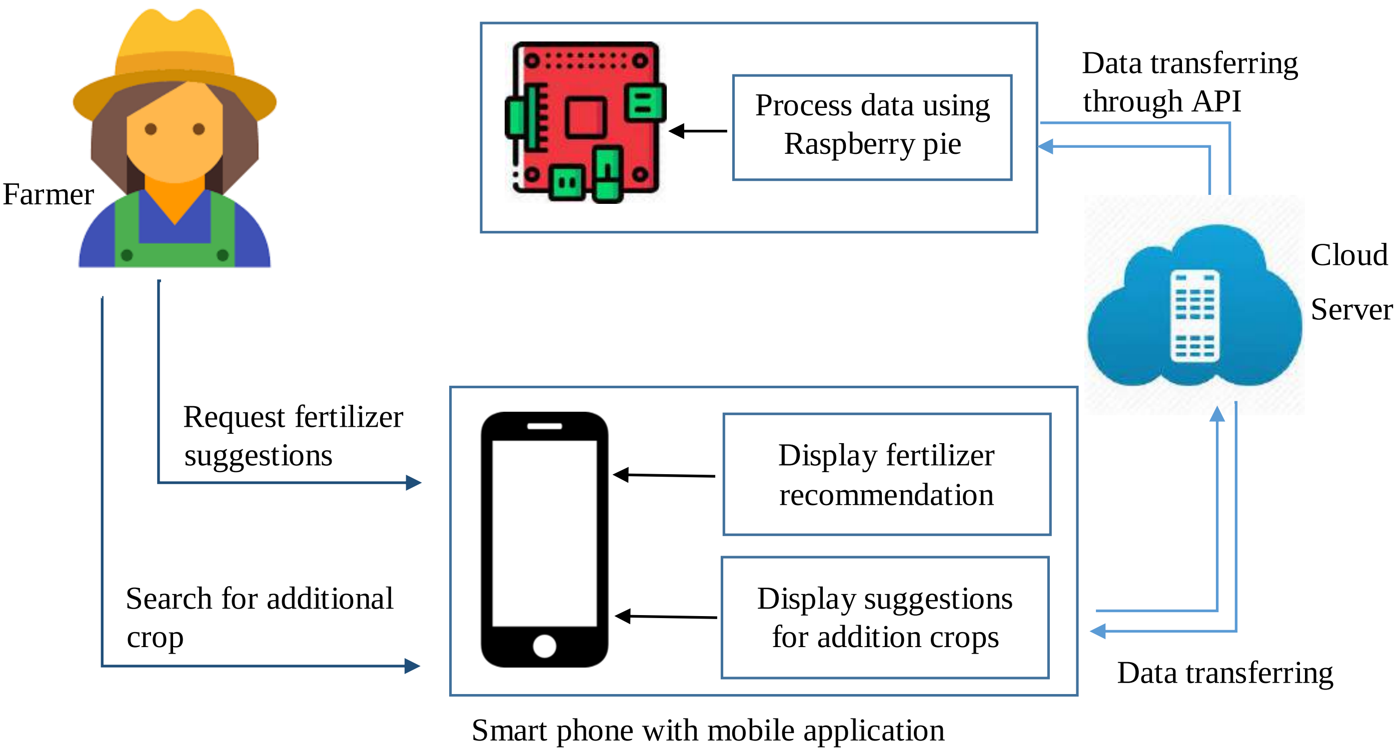

Figure 5 – High level architectural Design

3.2.2. Hardware and Software requirements with justification

As our proposed product will address to a common issue for the people who has an interest in cultivation, the final outcome should be more effective and accurate. Therefore, several software and hardware components have to be used for achieving this

Hardware requirements :

- pH sensor - Use to check the quality of the soil in a particular ground.
- EC sensor - Use to get the electrical conductivity of the soil.
- Humidity sensor - Use to identify the humidity of the air.
- Temperature sensor - Use to identify the temperature in the air.

Software Requirements

- Visual studio 2015 – Use to develop the mobile application using Xamarine
- phpMyAdmin – To perform MYSQL database management.
- Cloud – To store sensor readings and the area of the ground.

3.2.3. Risk mitigation plan with alternative solution identification

Risk	Impact	Likelihood (%)	Mitigation Plan
pH Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
Humidity Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
temperature Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
EC Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
If there no network coverage in this place	1	50%	Save the data mobile phone and after available network saved in the database
Machine learning algorithm result is less accurate	3	30%	Train the algorithm using more data sets

Table 5 – Risk mitigation plan

3.2.4. Cost benefit analysis for the proposed solution

Description	Quantity	Price (Rs)
Ph Sensor	1	350.00
Humidity sensor	1	350.00
Temperature Sensor	1	200.00
EC meter	1	450.00
HDMI to VGA adaptor	1	1225.00
Raspberry Pie 3 kit	1	7450.00
Screen for raspberry pi	1	1400.00
Memory card 16GB	1	1500.00
	Total	**12925.0**

Table 6 – Cost benefit analysis

3.3. Performance requirements

It is expected that the proposed system will perform all the requirements stated under the functional requirements section. Some performance requirements identified are listed below.

- The sensor readings must be accurate and trustworthy.
- The mobile application performance is going to depend on mobile phone's battery life, RAM and internet connectivity.
- Sensor details can transfer within less than one second.
- The system will operate with minimum 1GB RAM.

3.4. Design constraints

This product is focused on people without any age limitation, the user interfaces of the mobile application have to be simple, attractive as well as user-friendly. Therefore, people will be able to work with the proposed product easily and effectively with the use of these designed user interfaces.

3.5. Software system attributes

3.5.1. Reliability

As this product address a common issue of people who has an interest in cultivation, the reliability of the proposed product is important. According to this research component,

- The sensor readings must be 100% accurate because most important actions will be based on them.

- To data communication between cloud, internet connectivity should be enabled.

- The system will be tested using several techniques to make sure it's probability of failure is very low value.

- If there will be a failure in the system a proper mechanism is going to be implemented to show the failures.

- At a time of failure, there should be a way to overcome through that immediately.

3.5.2. Availability

- Always servers need to be available because this system functions working with server data.
- This application should be a real-time application. It is working with real-time data.
- When a user needs mobile phone reset or changes the mobile. We are going to implement the backup option to recover user details.
- The sensor sub system and the mobile application should be easily understandable to users and it should be real time

3.5.3. Security

For user sign up for the mobile application, unique email address or phone number needs to be used by the user. The login details of the user will be sent to the database in the encrypted version. Therefore, user details and other personal details will be secured.

3.5.4. Maintainability

The sensor sub system will be used to get the data through sensors. Other algorithms and functions to process the accurate results will be handled by using the Raspberry pie board and the cloud server. Therefore, if any change occurs in the system, it will be easier to maintain that situation by using an application update or changing the server data.

4.Supporting information

4.1 Appendices

[1]. S. Pudumalar, E. Ramanujam, R. H. Rajashree, C. Kavya, T. Kiruthika, and J. Nisha, "Crop recommendation system for precision agriculture," *2016 8th Int. Conf. Adv. Comput. ICoAC 2016*, pp. 32–36, 2017.

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